A Planetary System About to Form

Astrophysicists now tend to agree that as stars form by collapsing from the clouds of matter floating in interstellar space, the matter that may form planetary systems around them condenses with them. These planetary systems should begin to form at about the same time as the stars. The planetary matter should form a disk around the star.

Evidence for the first observation of such a preplanetary disk was presented at last week's meeting of the American Astronomical Society in Atlanta by Roger I. Thompson of the University of Arizona. The work was done by Thompson and P. A. Strittmatter of the University's Steward Observatory and E. F. Erickson, F. C. Witteborn and D. W. Strecker of NASA's Ames Laboratory.

The star in question is MWC 349 located in the constellation Cygnus. It is 7,000 to 8,000 light-years away. It appears to be what is called a zero-age main sequence star. This is a star that has recently begun nuclear burning and entered the main sequence of stellar evolution. Yet it appears to be 11 times as bright as it should be for that classification, indicating that something else associated with the star is contributing light. Furthermore, that brightness has been decreasing by about 1 percent a month for 40 years, a process that places some constraints on what the source of the extra light can be.

Spectral observations were begun a year and a half ago at Steward Observatory, and in June 1976 joint observations were undertaken by Steward and NASA's airborne Kuiper Observatory. The observatory flies above enough of the atmospheric absorption to be able to determine infrared features unobtainable from the ground.

The results gave a very unusual spectrum. As Thompson puts it, "If one couples the infrared and the optical, one gets numbers no one had ever found put together." Study of these numbers showed that they seem to fit a theoretical model of a hot viscous disk with the star in its center seen face on. The disk glows with heat produced by viscous friction as it rotates and thus contributes the extra brightness to the system.

From the data the observers can figure some numerical values for the properties of the disk. The luminous part of the disk extends one or two times as far as the earth is from the sun. Beyond the luminous part extends a dark region of uncertain extent. At the surface of the star the disk's thickness is about 1/20 of the radius of the star. The farther from the star the thicker it is, the thickness at any point being equal to 1/20 the distance from the center of the star.

Artist's conception of newly discovered star surrounded by a viscous disk of preplanetary material. Disk temperature diminishes with distance from the star.

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Near the star the disk is heated by the star, but farther out it glows from its own friction. Its temperature gradually drops off to the thousands and then hundreds of degrees at larger and larger distances from the star until finally the material is so cool that it does not glow. The mass of the matter in the luminous part of the disk is estimated at 0.015 the mass of the sun, and the average density is between 10^{18} and 10^{19} molecules per cubic centimeter. There is thus plenty of mass, high density and a cool region, says Thompson, the expected conditions for a preplanetary disk.

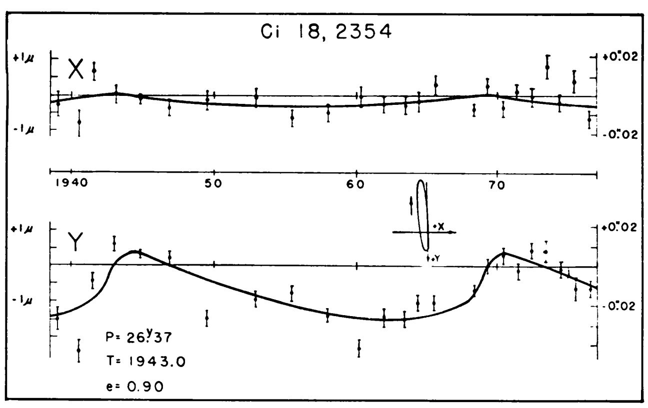
The star has not been engaged in nuclear burning for long, maybe about 10,000 years. The disk has been there longer, probably since the beginning of protostellar collapse, some tens or hundreds of millions of years ago. The star has about 30 times the mass of the sun, and therefore, according to the accepted theories of stellar evolution, it should evolve faster than the sun did. It has taken about 5 billion years to get the sun (and the solar system) to its present state; MWC 349 will get to the sun's present state much faster, but whether the planetary system will evolve in synchrony with the star or by a timescale of its own is unknown.

Thompson says he expects the observation to raise controversy. It infers a great deal from the spectroscopic evidence, a great deal that is novel, and already some muttering could be heard in the corridors. It is also a rare observation. Asked about the probability of seeing such a system, Thompson replied that there ought to be "several we might take a look at. We were lucky to see this one face on." □

A planet for a third nearby star?

If a visible star has a dark companion (dead star or planet) orbiting it, the companion will cause a cyclic wobble in the motion of the visible star across the sky. If the wobble is large enough and the star near enough, the wobble can be discovered by measuring photographs of the star taken over a period of years. Quite a number of dark stars have been discovered by this method, but when it comes to planet-sized bodies, the wobbles are so small that the star has to be very near, and even then a claim causes a lot of controversy.

Nevertheless, the existence of planets or planetlike bodies accompanying two stars has been claimed for two cases, Barnard's star and Epsilon Eridani, by Peter



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Cyclic wobbles in two dimensions plotted for Cincinnati 2354 and the companion's highly elliptical orbit derived from them.